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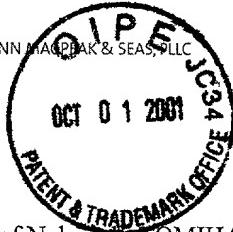
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Commissioner for Patents  
Washington, D.C. 20231



October 1, 2001

PCT/JP00/01756

-filed March 23, 2000

Re: Application of Nobuyuki TOMIHASHI, Koichiro OGITA and  
Toshio MIYATANI ✓  
FLUORINE-CONTAINING RESIN POWDER COATING COMPOSITION  
Assignee: DAIKIN INDUSTRIES, LTD.  
Our Ref: Q65919

Dear Sir:

The following documents and fees are submitted herewith in connection with the above application for the purpose of entering the National stage under 35 U.S.C. § 371 and in accordance with Chapter II of the Patent Cooperation Treaty:

- an executed Declaration and Power of Attorney.
- an English translation of the International Application.
- an executed Assignment and PTO 1595 form.
- International Search Report, Information Disclosure Statement and a Form PTO-1449.
- Notification Concerning Submission or Transmittal of Priority Document.
- a Preliminary Amendment.

It is assumed that copies of the International Application, the International Preliminary Examination Report, and any Articles 19 and 34 amendments as required by § 371(c) will be supplied directly by the International Bureau, but if further copies are needed, the undersigned can easily provide them upon request.

The Government filing fee, after entry of the Preliminary Amendment, is calculated as follows:

Total claims	24	-	20	=	4	x	\$18.00	=	\$72.00
Independent claims	1	-	3	=		x	\$84.00	=	\$0.00
Base Fee									\$890.00

<b>TOTAL FILING FEE</b>	<b>\$962.00</b>
<b>Recordation of Assignment</b>	<b>\$40.00</b>
<b>TOTAL FEE</b>	<b>\$1002.00</b>

Checks for the statutory filing fee of \$962.00 and Assignment recordation fee of \$40.00 are attached. You are also directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 19-4880. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16, 1.17 and 1.492 which may be required during the entire pendency of the application to Deposit Account No. 19-4880. A duplicate copy of this transmittal letter is attached.

Priority is claimed from March 29, 1999 based on Japanese Application No. 86898/1999.

Respectfully submitted,

  
 Abraham J. Rosner  
 Registration No. 33,276

AJR/amt

09/937705  
410 Rec'd PCT/PTO 01 OCT 2001

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Nobuyuki TOMIHASHI, et al.

Appln. No.: Not Yet Assigned

Confirmation No.: Not Yet Assigned

Group Art Unit: Not Yet Assigned

Filed: October 1, 2001

Examiner: Not Yet Assigned

For: FLUORINE-CONTAINING RESIN POWDER COATING COMPOSITION

**PRELIMINARY AMENDMENT**

Commissioner for Patents  
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

**IN THE CLAIMS:**

**Please cancel claims 5-21 and 23 without prejudice or disclaimer.**

**Please enter the following amended claims:**

3. The coating composition of Claim 1, wherein the fluorine-containing resin composition for forming a coating film comprises a fluorine-containing resin, a thermal stabilizer and surface-treated rutile titanium oxide particles.

22. A coating film which is a fluorine-containing resin coating film obtained by applying the powder coating composition of Claim 1 and baking at 300°C or more and has a whiteness of 60 or more.

24. An article having the coating film of Claim 22 on a surface thereof.

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25. A tank for medicines, foods and medical hygiene, which has the coating film of Claim 22 on an inner surface thereof.

26. A chemical equipment and parts thereof having the coating film of Claim 22 on an outer surface thereof.

Please add the following new claims:

27. (new) The coating composition of Claim 1, wherein the fluorine-containing resin is a melt-moldable perfluoro resin.

28. (new) The coating composition of Claim 27, wherein the perfluoro resin is a copolymer of tetrafluoroethylene, perfluoro(alkyl vinyl ether) and/or hexafluoropropylene.

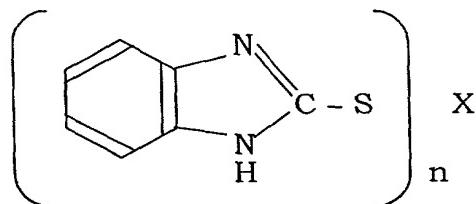
29. (new) The coating composition of Claim 3, wherein the thermal stabilizer has a melting point of not less than 70°C and comprises an organosulfurous thermal stabilizer, amine thermal stabilizer and/or metal powder thermal stabilizer.

30. (new) The coating composition of Claim 29, wherein the organosulfurous thermal stabilizer and amine thermal stabilizer are used together or the organosulfurous thermal stabilizer, amine thermal stabilizer and metal powder thermal stabilizer are used together.

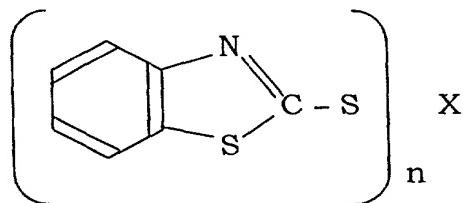
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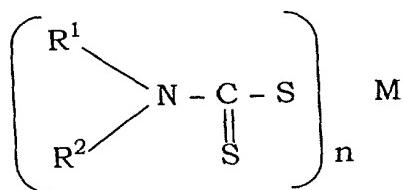
31. (new) The coating composition of Claim 29, wherein the organosulfurous thermal stabilizer is one or more of a benzimidazole mercaptan compound represented by the formula (I):



wherein X is H, Zn, Sn or Cd, n is an integer of 1 to 4,  
a benzothiazole mercaptan compound represented by the formula (II):



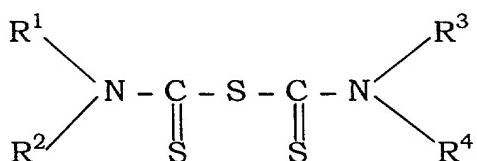
wherein X is H, Zn, Sn or Cd, n is an integer of 1 to 4,  
a thiocarbamic acid represented by the formula (III):



## **AMENDMENT**

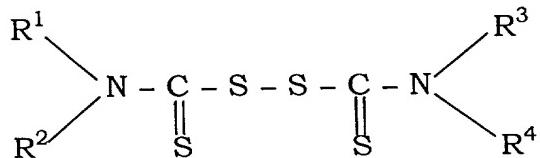
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wherein R<sup>1</sup> and R<sup>2</sup> are an aryl group or alkyl group having 2 to 16 carbon atoms, M is Zn, Sn, Cd or Cu, n is an integer of 1 to 4, or a salt thereof, a thiuram monosulfide represented by the formula (IV):



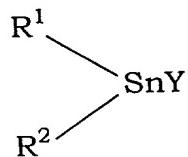
wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup> are an aryl group or alkyl group having 2 to 16 carbon atoms,

a thiuram disulfide represented by the formula (V):



wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup> are an aryl group or alkyl group having 2 to 16 carbon atoms, and

an organotin mercaptide compound represented by the formula (VI):



wherein Y is a mercaptan residue, R<sup>1</sup> and R<sup>2</sup> are the same or different and each is an aryl group or alkyl group having 2 to 16 carbon atoms.

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**32. (new)** The coating composition of Claim 31, wherein the organosulfurous thermal stabilizer is a benzothiazole mercaptan compound represented by the formula (II).

**33. (new)** The coating composition of Claim 29, wherein the amine thermal stabilizer is an aromatic amine thermal stabilizer having three or more benzene rings and having a melting point of not less than 80°C.

**34. (new)** The coating composition of Claim 33, wherein the aromatic amine thermal stabilizer is 4,4-bis( $\alpha,\alpha$ -dimethylbenzyl)diphenylamine.

**35. (new)** The coating composition of Claim 29, wherein the metal powder thermal stabilizer is one or more of cobalt powder, iron powder, zinc powder, tin powder and copper powder.

**36. (new)** The coating composition of Claim 3, wherein the thermal stabilizer comprises the organosulfurous thermal stabilizer represented by the formula (II) of Claim 31 and the aromatic amine thermal stabilizer having three or more benzene rings and a melting point of not less than 80°C.

**37. (new)** The coating composition of Claim 36, wherein the thermal stabilizer comprises a zinc salt of 2-mercaptopbenzothiazole and 4,4-bis( $\alpha,\alpha$ -dimethylbenzyl)diphenylamine.

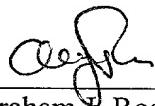
**38. (new)** The coating composition of Claim 36, wherein the thermal stabilizer comprises a zinc salt of 2-mercaptopbenzothiazole and 4,4-bis( $\alpha,\alpha$ -dimethylbenzyl)diphenylamine in a weight ratio of 50/50 to 99/1.

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**REMARKS**

Entry and consideration of this Amendment is respectfully requested.

Respectfully submitted,

  
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 Date: October 1, 2001

AMENDMENT

Attorney Docket No.: Q65919

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

**Claims 5-21 and Claim 23 are canceled.**

**The claims are amended as follows:**

3. The coating composition of Claim 1-~~or 2~~, wherein the fluorine-containing resin composition for forming a coating film comprises a fluorine-containing resin, a thermal stabilizer and surface-treated rutile titanium oxide particles.

22. A coating film which is a fluorine-containing resin coating film obtained by applying the powder coating composition of ~~any of~~ Claims 1-to-21 and baking at 300°C or more and has a whiteness of 60 or more.

24. An article having the coating film of Claim 22 ~~or~~ 23-on a surface thereof.

25. A tank for medicines, foods and medical hygiene, which has the coating film of Claim 22 ~~or 23~~-on an inner surface thereof.

26. A chemical equipment and parts thereof having the coating film of Claim 22 ~~or 23~~-on an outer surface thereof.

**Claims 27-38 are added as new claims.**

- 1 -

## DESCRIPTION

### FLUORINE-CONTAINING RESIN POWDER COATING COMPOSITION

5

#### TECHNICAL FIELD

The present invention relates to a fluorine-containing resin powder coating composition which gives a fluorine-containing resin coating film having a high whiteness and to various articles having the fluorine-containing resin coating film.

10

#### BACKGROUND ART

Fluorine-containing resin coatings have been used widely for coating of an outer surface of chemical equipment and parts of a plant of chemical industry such as a reaction tank, reservoir tank, reaction 15 tower, inner lining of piping, agitator and processing roll by making the best use of excellent properties of a fluorine-containing resin such as solvent resistance, heat resistance, non-sticking property, chemical resistance and electrically insulating property.

The fluorine-containing resin powder coating composition is 20 subjected to baking at high temperature, particularly at 300°C or more after the coating, and therefore foaming arises easily due to thermal deterioration of the fluorine-containing resin, and addition of a thermal stabilizer is essential.

The addition of a thermal stabilizer can inhibit the 25 deterioration of the fluorine-containing resin considerably. However since the thermal stabilizer is deteriorated, there is a problem that the fluorine-containing resin coating film which is originally transparent

and white is subject to a change in color into brown or black or non-uniformity of color after the baking due to a residue of the deteriorated stabilizer. Thermal deterioration of the fluorine-containing resin is also considered as a cause for the color change.

5 On the other hand, in the fields of medicines, foods and medical hygiene, from a point that staining of tanks for synthesis and storage of chemical substances is difficult to recognize when a dark coating is used and also from the viewpoint of appearance and cleanliness, a coating color is demanded to be as approximate to white  
10 as possible.

A usual method of making a color of coating film white is a method of incorporating a white pigment for coating. Examples of known white pigment are titanium oxide, calcium carbonate, zinc oxide, barium sulfate, and the like. The inventors of the present invention  
15 have made experiments and as a result in case of general-purpose white pigments for coating, non-uniformity of color arose and a satisfactory coating film could not be formed.

An another approach is a method of changing a thermal stabilizer. However even in this approach, a color change could not be  
20 inhibited only by changing the thermal stabilizer. Moreover the addition of the white pigment for coating still causes non-uniformity of color.

An object of the present invention is to provide a fluorine-containing resin powder coating composition which gives a fluorine-containing resin coating film having a high whiteness.  
25

Another object of the present invention is to provide various articles having on an outer surface thereof a coating film which has a

high whiteness and is obtained by applying the fluorine-containing resin powder coating composition.

#### DISCLOSURE OF INVENTION

5       Namely the present invention relates to the fluorine-containing resin powder coating composition to be subjected to baking at 300°C or more, in which the fluorine-containing resin composition for forming a coating film contains surface-treated rutile titanium oxide particles as a whitening agent.

10      In the present invention it is preferable that the fluorine-containing resin composition for forming a coating film comprises a fluorine-containing resin, a thermal stabilizer and surface-treated rutile titanium oxide particles and that the fluorine-containing resin is a perfluoro resin, particularly a melt-moldable perfluoro resin and the 15     thermal stabilizer has a melting point of not less than 70°C.

Further the present invention relates to the coating film which is obtained by applying the above-mentioned coating composition of the present invention and baking at 300°C or more and has a whiteness of 60 or more and relates to the articles having the coating 20     film on a surface thereof.

#### BEST MODE FOR CARRYING OUT THE INVENTION

The fluorine-containing resin to be used for the fluorine-containing resin composition for forming a coating film of the present 25     invention is one which can stand baking at 300°C. The fluorine-containing resin may be a perfluoro resin or a non-perfluoro resin such as vinylidene fluoride copolymer, ethylene-tetrafluoroethylene

copolymer or ethylene-chlorotrifluoroethylene copolymer. From the viewpoint of excellent heat resistance, solvent resistance, non-sticking property, chemical resistance and electrically insulating property, the perfluoro resin is preferable. Also among the perfluoro resins, melt-  
5 moldable perfluoro resins are preferred to polytetrafluoroethylene (PTFE) which is difficult to be melt-molded, from the point that a film forming property thereof is excellent and pin hole is difficult to arise.

Examples of the preferred melt-moldable perfluoro resin are tetrafluoroethylene (TFE) copolymers, for instance, copolymers of TFE  
10 with at least one of perfluoro(alkyl vinyl ethers) (PAVE) and hexafluoropropylene (HFP). Particularly TFE, PAVE and/or HFP copolymers, concretely TFE/PAVE copolymer (PFA), TFE/HFP copolymer (FEP) and TFE/PAVE/HFP copolymer are preferred.

Examples of PAVE are one or more of perfluoro(methyl vinyl ether) (PMVE), perfluoro(ethyl vinyl ether) (PEVE), perfluoro(propyl vinyl ether) (PPVE), and the like. Particularly PPVE is preferable.  
15

One of the features of the present invention is that the fluorine-containing resin composition for forming a coating film comprises surface-treated rutile titanium oxide particles as a whitening agent in addition to the fluorine-containing resin.  
20

It is necessary that titanium oxide to be used in the present invention is surface-treated and a crystalline form thereof is of rutile type. As shown in Comparative Examples mentioned hereinbelow, in case of un-treated titanium oxide which is a general-purpose white pigment for coating, non-uniformity of color arises, and also even in case  
25 of anatase titanium oxide which is titanium oxide having another crystalline form, non-uniformity of color occurs.

It is preferable that a surface-treating agent for rutile titanium oxide is one comprising aluminum oxide and/or silicon oxide, more preferably one containing silicon oxide in a larger amount.

An average particle size of titanium oxide is not limited particularly, and is, for example, from about 0.1  $\mu\text{m}$  to about 1.0  $\mu\text{m}$  which is a size of commercially available titanium oxide.

Examples of the surface-treated rutile titanium oxide to be used preferably in the present invention are, for instance, Tipaque (registered trademark) CR-90, CR-95 and CR-97 available from Ishihara

10 Sangyo Kaisha, Limited; Titanix (registered trademark) R-805 available from TAYCA CORPORATION; Ti-Pure (registered trademark) R-960 and R-902 available from Du Pont de Nemour E.I. & Co. Inc.; and the like. Also rutile titanium oxides surface-treated to the same extent as in those surface-treated rutile titanium oxides can be used preferably.

15 An amount of the surface-treated rutile titanium oxide is from 0.1 to 10 parts by weight (hereinafter referred to as "part"), preferably 0.5 to 10 parts, further preferably 1 to 5 parts based on 100 parts of the fluorine-containing resin. When less than 0.1 part, a desired whiteness cannot be given to a coating film, and when more than 20 parts, non-sticking property and corrosion resistance of the fluorine-containing resin coating film are lowered.

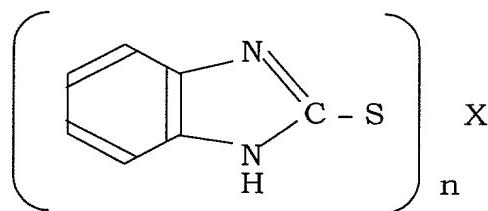
To the fluorine-containing resin powder coating composition of the present invention is blended a thermal stabilizer. While various known thermal stabilizers can be used, when dry-blending each 25 component for preparing a powder coating composition, since a temperature of the mixture becomes 60°C or more, usually 70°C or more, thermal stabilizers having a melting point of 70°C or more, preferably

80°C or more are used. This is a characteristic point of the powder coating composition with respect to the thermal stabilizer.

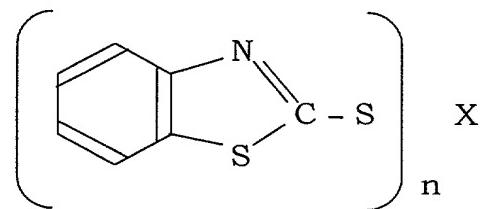
Examples of the preferable thermal stabilizer are those comprising an organosulfurous thermal stabilizer, amine thermal 5 stabilizer and/or metal powder thermal stabilizer.

Preferable combinations are a combination use of the organosulfurous thermal stabilizer and the amine thermal stabilizer and a combination use of the organosulfurous thermal stabilizer, the amine thermal stabilizer and the metal powder thermal stabilizer.

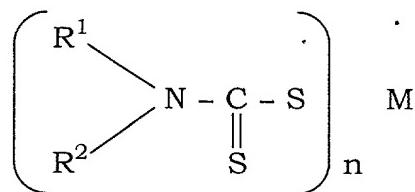
10 Examples of the organosulfurous thermal stabilizer are, for instance, one or more of benzimidazole mercaptan compounds represented by the formula (I):



wherein X is H, Zn, Sn or Cd, n is an integer of 1 to 4,  
20 benzothiazole mercaptan compounds represented by the formula (II):

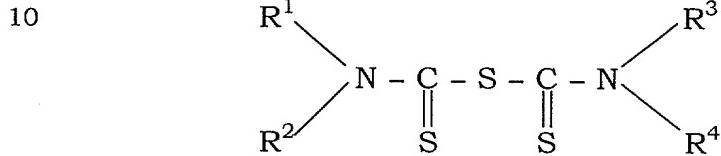


wherein X is H, Zn, Sn or Cd, n is an integer of 1 to 4,  
thiocarbamic acids represented by the formula (III):



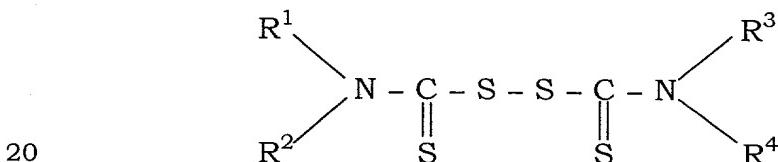
5 wherein each of  $R^1$  and  $R^2$  is an aryl group or alkyl group having 2 to 16 carbon atoms,  $M$  is  $Zn$ ,  $Sn$ ,  $Cd$  or  $Cu$ ,  $n$  is an integer of 1 to 4, or salts thereof,

thiuram monosulfides represented by the formula (IV):



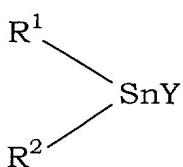
wherein each of  $R^1$ ,  $R^2$ ,  $R^3$  and  $R^4$  is an aryl group or alkyl group having  
15 2 to 16 carbon atoms,

thiuram disulfides represented by the formula (V):



wherein each of  $R^1$ ,  $R^2$ ,  $R^3$  and  $R^4$  is an aryl group or alkyl group having  
2 to 16 carbon atoms, and

organotin mercaptide compounds represented by the formula (VI):



5 wherein Y is a mercaptan residue, R<sup>1</sup> and R<sup>2</sup> are the same or different  
and each is an aryl group or alkyl group having 2 to 16 carbon atoms.

Examples thereof are, for instance, benzimidazole mercaptan compounds represented by the formula (I) such as 2-mercaptopbenzothiazole and 2-mercaptopbenzimidazole; benzothiazole 10 mercaptan compounds represented by the formula (II) such as a zinc salt of 2-mercaptopbenzothiazole; thiocarbamic acids represented by the formula (III) or salts thereof such as zinc ethylphenyldithiocarbamate and zinc dibutylthiocarbamate; thiuram monosulfides represented by the formula (IV) such as tetra-methyl-thiuram monosulfide; thiuram 15 disulfides represented by the formula (V) such as tetra-methyl-thiuram disulfide; and organotin mercaptide compounds represented by the formula (VI) such as dibutyltin maleate and dibutyltin mercaptide.

Among them, benzothiazole mercaptan compounds are preferable from the viewpoint of thermal stabilizing effect and chemical 20 resistance. Particularly a zinc salt of 2-mercaptopbenzothiazole is preferable.

With respect to the amine thermal stabilizer, aromatic amine thermal stabilizers having three or more benzene rings, preferably 3 or 4 benzene rings are preferable, and further those having a melting point of 25 not less than 80°C are preferable. The aromatic amine thermal stabilizers function to enhance a thermal stabilizing effect particularly when used together with the organosulfurous thermal stabilizer due to a

difference in a decomposition temperature.

Examples of the aromatic amine thermal stabilizer are, for instance, 4,4-bis( $\alpha,\alpha$ -dimethylbenzyl)diphenylamine, dinaphthylamine, phenyl- $\alpha$ -naphthylamine, phenyl- $\beta$ -naphthylamine, diphenyl-p-phenylenediamine, phenylcyclohexyl-p-phenylenediamine, aldol- $\alpha$ -naphthylamine, diphenylamine, and the like. Particularly 4,4-bis( $\alpha,\alpha$ -dimethylbenzyl)diphenylamine is preferable.

Examples of the metal powder thermal stabilizer are one or more of cobalt powder, iron powder, zinc powder, tin powder and copper powder. A combination use of the metal powder thermal stabilizer with the above-mentioned organosulfurous thermal stabilizer and amine thermal stabilizer is more preferable than a single use thereof.

A proportion in a weight ratio of the organosulfurous thermal stabilizer, amine thermal stabilizer and metal powder thermal stabilizer is 50 to 100/0 to 50/0 to 50, preferably 50 to 99/1 to 50/0 to 30.

An adding amount of the thermal stabilizer is from 0.1 to 3 parts, preferably 0.5 to 3.0 parts based on 100 parts of the fluorine-containing resin. When less than 0.1 part, a sufficient thermal stabilizing effect cannot be obtained, and when more than 3 parts, a whiteness of an obtained coating film is lowered.

A particularly preferable combination of thermal stabilizers is the organosulfurous thermal stabilizer represented by the formula (II) and the aromatic amine thermal stabilizer having three or more benzene rings and a melting point of 80°C or more. More concretely preferable is a combination of a zinc salt of 2-mercaptobenzothiazole and 4,4-bis( $\alpha,\alpha$ -dimethylbenzyl)diphenylamine desirably in a weight ratio of 50/50 to 99/1.

To the fluorine-containing resin powder coating composition of the present invention may be blended various additives for powder coating as far as a whiteness of an obtained coating film is not lowered remarkably. Examples of the additives are, for instance, an antistatic agent such as a carbon fiber, titanic acid whisker or carbon fluoride, a reinforcing agent such as a glass fiber or mica, and the like.

The powder coating composition of the present invention can be prepared by mixing in the same manner as in a usual method. For example, any of usual mixers such as a sample mill, V-blender, cone 10 blender and ribbon mixer and usual pulverizer can be used without any specific limitations. Also the composition can be used in the form of liquid or slurry obtained by dispersing the composition into an organic medium or aqueous medium.

An average particle size of the obtained powder coating 15 composition is within a range which has been used so far, for example, from 10 to 500  $\mu\text{m}$ , preferably about 20  $\mu\text{m}$  to about 300  $\mu\text{m}$ .

Also the same coating methods as usual, for example, static coating methods such as spray coating and fluidized bed coating, a method of lining by rotation molding, and the like can be used 20 optionally.

After coating, the coating film is subjected to baking at a temperature of 300°C or more, usually from 300° to 400°C. A thickness of the formed coating film is within a range of from 30 to 5,000  $\mu\text{m}$ . Concretely the coating thickness may be selected optionally depending 25 on purpose and application thereof. The composition may be coated thick by one coat or may be coated plural times by forming 30 to 150  $\mu\text{m}$  thick coating film by one coat. When coating plural times, it is

preferable that the baking is carried out for each coat from the viewpoint of adjusting a coating thickness.

A substrate to be coated is not limited as far as it can be coated with conventional fluorine-containing resin powder coating compositions. Non-restricted examples thereof are, for instance, metallic substrates such as aluminum, stainless steel, Ni alloy and metal die cast substrates; ceramic substrates such as glass and insulator substrates; and the like.

It is effective to previously surface-treat a surface of the substrate to be coated by sand blasting treatment, oxide film coating, or the like depending on kind of a substrate. Also a primer layer may be formed on the substrate. Particularly by forming the primary layer, non-uniformity of a color of the obtained coating film can be inhibited further.

A coating film which is rich in white and has a whiteness ( $L$  value) of 60 or more can be obtained by using the fluorine-containing resin powder coating composition of the present invention. Further a coating film having a whiteness of 70 or more, further 80 or more can be formed by increasing an amount of the above-mentioned preferable surface-treated rutile titanium oxide and by using the above-mentioned preferable combinations of thermal stabilizers.

The present invention also relates to the articles having a fluorine-containing resin coating film having such a high whiteness on its surface. Non-restricted examples of the articles which are obtained by using the coating film of the present invention are, for instance, chemical equipment and parts thereof contacting a chemical substance such as a reaction tank, storage tank, pipe, agitator, roll, valve, reaction

tower and centrifugal dehydrator.

The articles of the present invention are suitable particularly for uses in the fields of medicines, foods and medical hygiene because a whiteness thereof is high and detection of stain is easy.

5       The present invention is then explained by means of examples, but is not limited thereto.

#### EXAMPLE 1

An agitator (SPEED KNEADER available from Showa  
10 Engineering Kabushiki Kaisha) having a 50-liter agitation chamber equipped with four agitation blades was charged with 10 kg of FEP powder coating composition (NC1500 available from DAIKIN INDUSTRIES, LTD.) having an average particle size of 60  $\mu\text{m}$  and then 0.2 kg of a mixture of 4,4-bis( $\alpha$ ,  $\alpha$ -dimethylbenzyl)diphenylamine, zinc  
15 salt of 2-mercaptobenzothiazole and cobalt powder in a ratio of 3:3:2 (weight ratio) (stabilizer I in Table 1) and 0.5 kg of surface-treated rutile titanium oxide (Tipaque CR-93 available from Ishihara Sangyo Kaisha, Limited and surface-treated with a mixture of aluminum oxide/silicon oxide in a weight ratio of 2 to 5/3 to 5), followed by dry-blending at 1,500  
20 rpm for 30 minutes to give a FEP powder coating composition.

The FEP powder coating composition was applied on an aluminum panel and iron panel in the following manner and then subjected to baking. A whiteness (L value), non-uniformity of color and foaming of the obtained coating film were evaluated. The results are  
25 shown in Table 1.

(Whiteness)

The power coating composition is applied on an aluminum

panel ( $100 \times 100 \times 1.5$  mm) provided with a primer layer (EK1959DGN available from DAIKIN INDUSTRIES, LTD.) on its surface by electrostatic coating at an applied voltage of 40 kV with an electrostatic coating machine (GX3300 available from Onoda Cement Kabushiki Kaisha) so that a coating thickness after baking becomes about 100  $\mu\text{m}$ . After the coating, the baking is carried out at  $350^\circ\text{C}$  for 30 minutes in an electric oven. Then further the coating and baking are repeated two times (baking conditions at the third baking:  $340^\circ\text{C} \times 60$  minutes) to produce a test panel having a fluorine-containing resin coating film in a total coating thickness of about 250 to 300  $\mu\text{m}$ . A whiteness (L value) of the coating film is measured with SM color computer (model SM-7) available from Suga Shikenki Kabushiki Kaisha.

(Non-uniformity of color)

The coating film of test panel produced for measuring the whiteness is observed with naked eyes and evaluated according to the following criteria.

- A: No non-uniformity of color.
- B: Slight non-uniformity of color.
- C: Apparent non-uniformity of color.

(Degree of foaming)

A primer (EK1083GB available from DAIKIN INDUSTRIES, LTD.) is applied on an iron panel subjected to sand blasting, followed by drying at  $90^\circ\text{C}$  for 10 minutes and then baking at  $380^\circ\text{C}$  for 10 minutes. Further a primer (EK1883GB available from DAIKIN INDUSTRIES, LTD.) is applied thereon, dried and baked. A rectangular molding form of  $10 \times 10$  cm is placed on the primer layer and the powder coating composition is filled in the molding form so that a coating thickness becomes about

2,000 µm after the baking. After the molding form is removed carefully, the baking is carried out at 340°C for 14 hours in an electric oven. Then a foaming state of the coating film after the baking is observed with naked eyes and evaluated according to the following criteria.

- 5 A: No foaming is recognized.  
B: Slight foaming is recognized.  
C: Foaming is recognized on the whole surface.

#### EXAMPLES 2 to 6

10 Fluorine-containing resin powder coating compositions were prepared in the same manner as in Example 1 except that kind and amount of the thermal stabilizer and an amount of rutile titanium oxide were changed as shown in Table 1, and a whiteness (L value), non-uniformity of color and a degree of foaming were evaluated in the same  
15 manner as in Example 1. The results are shown in Table 1.

A thermal stabilizer used in Examples 5 and 6 was a mixture of 4,4-bis(α,α-dimethylbenzyl)diphenylamine and a zinc salt of 2-mercaptobenzothiazole in a ratio of 1:1 (weight ratio) (Stabilizer II in Table 1).

20

#### COMPARATIVE EXAMPLES 1 to 6

Fluorine-containing resin powder coating compositions were prepared in the same manner as in Example 1 except that kind and amount of the thermal stabilizer and an amount of rutile titanium oxide  
25 were changed as shown in Table 1, and a whiteness (L value), non-uniformity of color and a degree of foaming were evaluated in the same manner as in Example 1. The results are shown in Table 1.

In Comparative Examples 1 and 2, no thermal stabilizer was used, and in Comparative Examples 3 and 4, a mixture of a zinc salt of 2-mercaptobenzothiazole and di- $\beta$ -naphthyl-p-phenylenediamine in a ratio of 1:1 (weight ratio) (Stabilizer III in Table 1) was used as a thermal 5 stabilizer. Also in Comparative Example 5, rutile titanium oxide not subjected to surface treatment (FR-22 available from Furukawa Kogyo Kabushiki Kaisha) was used as a whitening agent, and in Comparative Example 6, anatase titanium oxide not subjected to surface treatment (FA-65 available from Furukawa Kogyo Kabushiki Kaisha) was used.

10

#### EXAMPLES 7 to 8

Fluorine-containing resin powder coating compositions were prepared in the same manner as in Example 1 except that PFA powder coating composition (AC5500 available from DAIKIN INDUSTRIES, LTD.) 15 was used as a fluorine-containing resin and a thermal stabilizer and whitening agent shown in Table 1 were used, and a whiteness (L value), non-uniformity of color and a degree of foaming were evaluated in the same manner as in Example 1. The results are shown in Table 1.

20

#### COMPARATIVE EXAMPLE 7

A fluorine-containing resin powder coating composition was prepared in the same manner as in Example 7 except that kind and amount of the thermal stabilizer and an amount of rutile titanium oxide were changed as shown in Table 1, and a whiteness (L value), non-25 uniformity of color and a degree of foaming were evaluated in the same manner as in Example 7. The results are shown in Table 1.

TABLE 1

Fluorine-containing resin	Thermal stabilizer		Whitening agent		Whiteness (L value)	Non-uniformity of color	Degree of foaming
	Kind	Amount (part by weight)	Kind	Amount (part by weight)			
Ex. 1	FEP	I	2	CR-93	5	77.7	A
Ex. 2	FEP	I	2	CR-93	3.5	72.8	A
Ex. 3	FEP	I	2	CR-93	2.5	68.1	A
Ex. 4	FEP	I	1	CR-93	2.5	76.5	A
Ex. 5	FEP	II	2	CR-93	5	80.8	A
Ex. 6	FEP	II	2	CR-93	3.5	78.1	A
Ex. 7	PFA	I	2	CR-93	3.5	73.0	A
Ex. 8	PFA	II	2	CR-93	3.5	77.3	A

- continued -

- continued -

Com. Ex. 1	FEP	-	-	CR-93	2.5	74.4	C	C
Com. Ex. 2	FEP	-	-	CR-93	0.5	76.2	B	C
Com. Ex. 3	FEP	III	2	CR-93	5	56.6	A	A
Com. Ex. 4	FEP	III	0.5	CR-93	5	59.1	A	C
Com. Ex. 5	FEP	I	2	FR-22	2.5	60.2	B	C
Com. Ex. 6	FEP	I	2	FA-65	5	58.9	B	C
Com. Ex. 7	PFA	III	2	CR-93	5	53.3	A	A

#### INDUSTRIAL APPLICABILITY

According to the present invention, a fluorine-containing resin powder coating composition giving a fluorine-containing resin coating film having a high whiteness can be provided, and various  
5 articles which can be produced by applying the fluorine-containing resin powder coating composition and have a coating film having a high whiteness on its outer surface can be provided.

THE UNITED STATES PATENT AND TRADEMARK OFFICE

CLAIMS

1. A fluorine-containing resin powder coating composition to be subjected to baking at 300°C or more, in which the fluorine-containing resin composition for forming a coating film comprises surface-treated rutile titanium oxide particles as a whitening agent.
2. The coating composition of Claim 1, wherein the surface-treated rutile titanium oxide particles are rutile titanium oxide surface-treated with aluminum oxide and/or silicon oxide.
3. The coating composition of Claim 1 or 2, wherein the fluorine-containing resin composition for forming a coating film comprises a fluorine-containing resin, a thermal stabilizer and surface-treated rutile titanium oxide particles.
4. The coating composition of Claim 3, wherein the fluorine-containing resin composition for forming a coating film comprises 0.3 to 3 parts by weight of the thermal stabilizer and 0.5 to 10 parts by weight of the surface-treated rutile titanium oxide particles based on 100 parts by weight of the fluorine-containing resin.
5. The coating composition of any of Claims 1 to 4, wherein the fluorine-containing resin is a perfluoro resin.
6. The coating composition of Claim 5, wherein the perfluoro resin is a melt-moldable perfluoro resin.

7. The coating composition of Claim 6, wherein the perfluoro resin is a copolymer of tetrafluoroethylene, perfluoro(alkyl vinyl ether) and/or hexafluoropropylene.

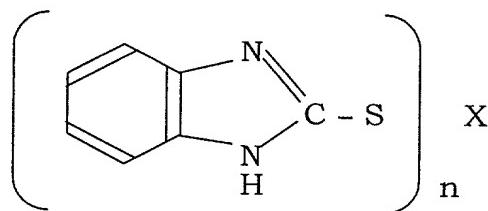
5       8. The coating composition of any of Claims 3 to 7, wherein the thermal stabilizer has a melting point of not less than 70°C.

10      9. The coating composition of any of Claims 3 to 8, wherein the thermal stabilizer comprises an organosulfurous thermal stabilizer, amine thermal stabilizer and/or metal powder thermal stabilizer.

15      10. The coating composition of Claim 9, wherein the organosulfurous thermal stabilizer and amine thermal stabilizer are used together.

11      11. The coating composition of Claim 9, wherein the organosulfurous thermal stabilizer, amine thermal stabilizer and metal powder thermal stabilizer are used together.

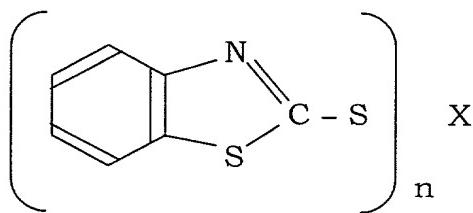
20      12. The coating composition of any of Claims 9 to 11, wherein the organosulfurous thermal stabilizer is one or more of a benzimidazole mercaptan compound represented by the formula (I):



wherein X is H, Zn, Sn or Cd, n is an integer of 1 to 4,

a benzothiazole mercaptan compound represented by the formula (II):

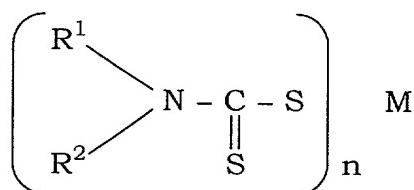
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wherein X is H, Zn, Sn or Cd, n is an integer of 1 to 4,

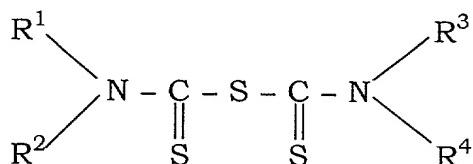
10 a thiocarbamic acid represented by the formula (III):

15



wherein R<sup>1</sup> and R<sup>2</sup> are an aryl group or alkyl group having 2 to 16 carbon atoms, M is Zn, Sn, Cd or Cu, n is an integer of 1 to 4, or a salt thereof, a thiuram monosulfide represented by the formula (IV):

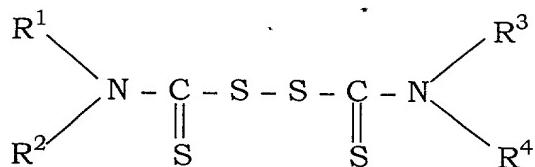
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wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup> are an aryl group or alkyl group having 2 to 16

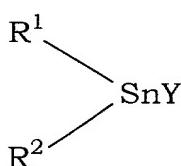
25 carbon atoms,

a thiuram disulfide represented by the formula (V):



5 wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup> are an aryl group or alkyl group having 2 to 16 carbon atoms, and

an organotin mercaptide compound represented by the formula (VI):



wherein Y is a mercaptan residue, R<sup>1</sup> and R<sup>2</sup> are the same or different and each is an aryl group or alkyl group having 2 to 16 carbon atoms.

15

13. The coating composition of Claim 12, wherein the organosulfurous thermal stabilizer is a benzothiazole mercaptan compound represented by the formula (II).

20

14. The coating composition of Claim 12, wherein the organosulfurous thermal stabilizer is a zinc salt of 2-mercaptobenzothiazole.

15. The coating composition of any of Claims 3 to 14, wherein  
25 the amine thermal stabilizer is an aromatic amine thermal stabilizer  
having three or more benzene rings.

16. The coating composition of Claim 15, wherein the aromatic amine thermal stabilizer is a compound having a melting point of not less than 80°C.

5        17. The coating composition of Claim 16, wherein the aromatic amine thermal stabilizer is 4,4-bis( $\alpha,\alpha$ -dimethylbenzyl)diphenylamine.

10      18. The coating composition of any of Claims 3 to 9 and 11 to 15, wherein the metal powder thermal stabilizer is one or more of cobalt powder, iron powder, zinc powder, tin powder and copper powder.

15      19. The coating composition of any of Claims 3 to 7, wherein the thermal stabilizer comprises the organosulfurous thermal stabilizer represented by the formula (II) and the aromatic amine thermal stabilizer having three or more benzene rings and a melting point of not less than 80°C.

20      20. The coating composition of Claim 19, wherein the thermal stabilizer comprises a zinc salt of 2-mercaptobenzothiazole and 4,4-bis( $\alpha,\alpha$ -dimethylbenzyl)diphenylamine.

25      21. The coating composition of Claim 19, wherein the thermal stabilizer comprises a zinc salt of 2-mercaptobenzothiazole and 4,4-bis( $\alpha,\alpha$ -dimethylbenzyl)diphenylamine in a weight ratio of 50/50 to 99/1.

22. A coating film which is a fluorine-containing resin coating film obtained by applying the powder coating composition of any of Claims 1 to 21 and baking at 300°C or more and has a whiteness of 60 or more.

5

23. The coating film of Claim 22, wherein the whiteness (L value) is 70 or more.

24. An article having the coating film of Claim 22 or 23 on a  
10 surface thereof.

25. A tank for medicines, foods and medical hygiene, which has the coating film of Claim 22 or 23 on an inner surface thereof.

15 26. A chemical equipment and parts thereof having the coating film of Claim 22 or 23 on an outer surface thereof.

RECORDED - SEARCHED - INDEXED - SERIALIZED - FILED

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

特許出願宣言書  
Japanese Language Declaration

私は、下欄に氏名を記載した発明者として、以下のとおり宣言する：

私の住所、郵便の宛先および国籍は、下欄に氏名に続いて記載したとおりであり、

名称の発明に関し、請求の範囲に記載した特許を求める主題の本来の、最初にして唯一の発明者である（一人の氏名のみが下欄に記載されている場合）か、もしくは本来の、最初にして共同の発明者である（複数の氏名が下欄に記載されている場合）と信じ、

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

FLUORINE-CONTAINING RESIN

POWDER COATING COMPOSITION

その明細所を  
(該当する方に印を付す)

ここに添付する。

第\_\_\_\_\_日に出願番号第\_\_\_\_\_号として提出し、  
\_\_\_\_\_日に補正した。  
(該当する場合)

私は、前記のとおり補正した請求の範囲を含む前記明細書の内容を検討し、理解したことを陳述する。

私は、連邦規則法典第37部第1章第56条(a)項に従い、本願の審査に所要の情報を開示すべき義務を有することを認める。

the specification of which  
(check one)

is attached hereto

was filed on March 23, 2000 as  
PCT International  
Appln. Ser. No. PCT/JP00/01756  
and was amended on \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understood the contents of the above-identified specification, including the claims, as amended by any amendments referred to above.

I acknowledge the duty to disclose information in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

119 条 願先権日出に  
出優先願許下  
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I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior foreign applications:  
先の外国出願:

Priority claimed  
優先権の主張

86898/1999 ————— Japan —————  
Number                                   Country  
番号                                        国名

March 29, 1999  
Filing date  
出願の年月日

Yes       No  
あり      なし

Number      Country  
番号      国名

Filing date  
出願の年月日

Yes       No  
あり      なし

Number \_\_\_\_\_ Country \_\_\_\_\_  
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Filing date  
出願の年月日

Yes       No  
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I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior of the prior application and the national or PCT International filing date of this application:

Appn. Ser. No.  
出願番号

Filing Date  
出願日

Status (patd., pend., abndnd.)  
現況(特許済み、係属中、放棄済み)

Appn. Ser. No.  
出願番号

Filing Date  
出願日

Status (patd., pend., abndnd.)  
現況(特許済み、係属中、放棄済み)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorneys to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

I hereby appoint John H. Mion, Reg. No. 18,879; Donald E. Zinn, Reg. No. 19,046; Thomas J. Macpeak, Reg. No. 19,292; Robert F. Seas, Jr., Reg. No. 21,092; Darryl Mexic, Reg. No. 23,063; Robert V. Sloan, Reg. No. 22,775; Peter D. Olexy, Reg. No. 24,513; J. Frank Osha, Reg. No. 24,625; Waddell A. Biggart, Reg. No. 24,861; Robert G. McMorrow, Reg. No. 19,093; Louis Gubinsky, Reg. No. 24,835; Neil B. Siegel, Reg. No. 25,200; David J. Cushing, Reg. No. 28,703; John R. Inge, Reg. No. 26,916; Joseph J. Ruch, Jr., Reg. No. 26,577; Sheldon I. Landsman, Reg. No. 25,430; Richard C. Turner, Reg. No. 29,710; Howard L. Bernstein, Reg. No. 25,665; Alan J. Kasper, Reg. No. 25,426; Kenneth J. Burchfiel, Reg. No. 31,333; Gordon Kit, Reg. No. 30,764; Susan J. Mack, Reg. No. 30,951; Frank L. Bernstein, Reg. No. 31,484; Mark Boland, Reg. No. 32,197; William H. Mandir, Reg. No. 32,156; Scott M. Daniels, Reg. No. 32,562; Brian W. Hannon, Reg. No. 32,778; Abraham J. Rosner, Reg. No. 33,276; Bruce E. Kramer, Reg. No. 33,725; Paul F. Neils, Reg. No. 33,102; and Brett S. Sylvester, Reg. No. 32,765, my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and request that all correspondence about the application be addressed to **SUGHRUE, MION, ZINN, MACPEAK & SEAS**, 2100 Pennsylvania Avenue, N.W., Washington, D.C. 20037-3202.

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Fourth Inventor's signature Date  
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Fifth Inventor's signature Date  
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Post office address  
郵便の宛先

Full name of sixth joint inventor (if any)  
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Sixth Inventor's signature Date  
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郵便の宛先